

Alaska FACE

FATALITY ASSESSMENT & CONTROL EVALUATION

Welder killed in tank explosion

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SUMMARY

A 44-year-old male welder was killed while welding on a 55-foot wastewater recovery tank. At the time of the incident, the victim was in the process of welding a pipe onto an empty tank. Residual material from inside the tank ignited and the tank exploded. Fire and emergency medical services arrived and located the victim's body outside of the building across the road.

Based on the findings of the investigation, to prevent similar occurrences, employers should:

- **Ensure that a competent person inspects all hot work sites and tests conditions within containment vessels and associated structures.**
- **Ensure that structures contaminated with organic materials are never inerted with steam;**
- **Ensure workers are capable of recognizing and avoiding hazardous situations.**

INTRODUCTION

At 2:15 PM on February 18, 2000, a 44-year-old welder was killed when vapors from a wastewater recovery tank were ignited, causing the tank to explode. On March 19, 2000, Alaska Department of Labor and Workforce Development (AKDOLWD) notified the Alaska Division of Public Health, Section of Epidemiology. An investigation involving an injury prevention specialist for the Alaska Department of Health and Social Services, Section of Epidemiology, ensued on March 27, 2000. The incident was reviewed with

AKDOLWD officials. Police department, fire department, Medical Examiner and AKDOLWD reports were requested.

The wastewater recovery company in this incident had been in business since 1994. It employed three workers including one hazardous material (hazmat) technician. The company also employed one to three temporary labors. The victim was an experienced welder and had been employed by the company to construct a wastewater recovery system. The victim had been associated with the company since its move to its current location in 1999. At the time of the incident the victim was working on the ventilation system on one of two 9,500-gallon water treatment tanks. The company had an operation manual and a health and safety program. Safety training was on the job and addressed hazardous waste operations, hazard communication, personal protective equipment, confined space entry, and spill response. At the time of the incident, the company was reviewing and modifying its health and safety program to include a hot work program on equipment currently in service. The hot work procedure was not in place at the time of the incident.

INVESTIGATION

The incident occurred inside a building housing the wastewater recovery system at a privately owned industrial site. The building also housed the company office, pumping/loading areas, and storage area for 50-gallon barrels of contaminated wastewater. A doorway was located at the front of the building. At the side of the building was a large garage door, which allowed access to the pumping/loading and storage areas inside of the building where trucks could pump off collected wastewater. The recovery system was located inside the building constructed of metal framing and siding on a concrete floor. The floor did not have any drains and was sloped toward a containment sump. The system included two 20,000-gallon used oil treatment tanks, two 9,500-gallon water treatment tanks, a vapor scrubber, carbon filter, steam boiler, and a glycol treatment tank. All tanks were also inside a containment area that was capable of holding the contents of one entire tank.

The company collected water that was contaminated with organic compounds (crude oil and other petroleum products.) Collected water was first treated in oil recovery/treatment tanks and then transferred to the water treatment tanks. Inside the bottom of the water treatment tank is a steam coil to heat the contents by radiant heat. The heated contents of the tank were passed through activated charcoal filters. The filtrate (wastewater) was tested to ensure that it was within federal environmental specifications before being discharged into the municipal sewer system.

The tank involved in this incident was one of two 9,500-gallon water treatment tanks. The heating process produced a mixture of water and organic vapors and gases. A vertical vent pipe at the top of each of the wastewater tanks vented the vapors and gases to interior of the building. The company was modifying the tank ventilation to extend the ventilation pipe through the roof. The water treatment tank had been used for containment only.

On the day of the incident, the victim was working on top of the water treatment tanks, modifying the steam and ventilation lines to vent gases and vapors out of the building. He had been assisted off and on by another company employee. Prior to beginning work, the victim, company owner/operator, and hazmat technician discussed the hot work site on the outside of the tank. The tank was empty but not clean. Residual organic compounds still coated surfaces inside the tank. The need to inert the tank and associated ventilation lines was discussed. It was decided to inert the inside of the tank and adjoining ventilation lines using steam to deplete oxygen within the tank and minimize the risk of igniting the residual material. A large hose (steam hose) was attached to the base of the tank and connected to a steam house. A valve on the steam line regulated the flow of steam into the tank. Once the tank was filled, the steam would flow out of the top of the pipe. The valve was completely open prior to the departure of the hazmat technician from the building.

Prior to the explosion, a co-worker saw the victim working on top of the tank. An arc welding system was located near the base of the tank. It was surmised that the victim

begun welding a flange on the ventilation pipe of the tank when the explosion occurred. The explosion blew off the top of the tank, leaving the sides intact. The roof above the tank and a portion of the side of the building was ripped away. The victim was thrown approximately 150 feet away from the building. A worker in the adjacent office called 911. Emergency medical, law enforcement and fire department personnel responded to the call. The victim, the only injured person, was declared dead at the scene.

It is probable that the steam volatilized residual material on the inside surface of the tank. Post-incident examination of the valve used to regulate steam flow into the tank was found nearly closed. Emergency response reports do not state that any emergency responders closed the valve to stop the flow of steam into the tank. It was theorized that the victim had closed the valve to reduce the flow of steam. Possible reasons for this action were—

- The victim anticipated that the tank was filled and the atmosphere was inert;
- Escaping steam at the flange prohibited a high-quality weld.

The explosion was likely to have been triggered by ignitable vapors that collected at the junction of the flange causing combustion of the vaporized material within the tank. The composition of the vaporous material was unknown, however the composition and concentration material at the area of the flange and inside the tank were within explosive limits.

CAUSE OF DEATH

The medical examiner's report listed the cause of death as massive blunt force injuries from an explosion.

RECOMMENDATIONS

Recommendation #1: Employers should ensure that a competent person inspects all hot work sites and tests conditions within containment vessels and associated structures.

Discussion: While the victim in this incident was an experienced welder, neither he nor the company had experience testing atmospheric conditions prior to initiating hot work on tanks and associated structures contaminated with organic compounds. 29 CFR 1910.252 (a) (2) (iv) requires a work area to be inspected before cutting or welding takes place. This inspection must be done by a person who is 1) capable of identifying existing and predictable hazards at the work area or work conditions that are hazardous or dangerous, and 2) authorized to take prompt corrective actions.

Hot work inspection criteria would include, but not limited to—

- Review of a work plan;
- Visual inspection of the site;
- Atmospheric testing for combustible gases and vapors;
- Evaluation of flammability hazards and risk of explosion;
- Implementation of ventilation, purge, and cleaning techniques to control flammable vapors and eliminate the risk of explosion.

When these tasks are not within the scope of practice or expertise of designated safety personnel, employers should ensure consultative services are retained, such as a certified safety professional or industrial hygienist, to inspect a hot work site and conduct necessary analysis prior to the initiation of any welding activities.

Recommendation #2: Employers should ensure that structures contaminated with organic materials are never inerted with steam.

Discussion: In this incident, the tank was filled with steam to deplete the oxygen atmosphere. In theory, steam could be used as an inerting gas to displace oxygen. While

organic materials such as heating oil and crude oil is normally in a liquid state, these substances can be vaporized when heated. These organic vapors have greater combustibility. In this incident, residue coating interior surfaces was a probable hydrocarbon but of an unknown composition. The residue was most likely volatilized when exposed to steam being used to “inert” the interior of the tank and adjoining pipes. For example, diesel fuel oil has a flash point between 110 – 125 degrees F. At this temperature range vapors are flammable when in contact with an ignition source, such as a spark from a welder’s torch.

Post-event inspection of the site indicated that the steam valve had been nearly or completely shut off. The reduced flow of steam through the ventilation lines atop of the tank may have allowed volatile vapors to collect and be trapped at the top of the tank.

Recommendation #3: Employers should ensure workers are capable of recognizing and avoiding hazardous situations.

Discussion: All cutting and welding processes can produce sparks and spatter. Welders must be knowledgeable of all welding hazards, including sources of potential combustible materials, substances, and vapors, and need to guard against the ignition of these potentially hazardous materials to assure personal safety and ensure work site safety. If there is doubt about the combustibility of materials, a competent person consulted and the materials tested.

In addition, employers should ensure that all workers are trained in established policies and practices that are applicable to their tasks. A post-training evaluation and subsequent task review by a direct supervisor to help reinforce knowledge and practices.

REFERENCES

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Fatality Assessment and Control Evaluation (FACE) Project

The Alaska Division of Public Health, Section of Community Health and Emergency Medical Services performs Fatality Assessment and Control Evaluation (FACE) investigations through a cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR). The goal of these evaluations is to prevent fatal work injuries in the future by studying the working environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact.

Additional information regarding this report is available from:

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